FLEXIBLE HARQ ACK/NACK TRANSMISSION

BACKGROUND

[0001] 1. Field

[0002] Embodiments of the invention relate to standards for wireless communication of data, such as, but not limited to, 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE)/LTE-Advanced and standards for 3GPP LTE systems that are deployed in a local area.

[0003] 2. Description of the Related Art

[0004] In LTE Release 8, LTE Release 9, and LTE Release 10, a fixed Hybrid Automatic Repeat Request (HARQ) timing was defined and the process for Acknowledged/Not Acknowledged (ACK/NACK) transmission was specified.

[0005] As described in LTE Release 8, LTE Release 9, and LTE Release 10, for time division duplex (TDD), the user equipment (UE) transmits the ACK/NACK response in an uplink (UL) subframe n. The UE transmits this response upon detection of a Physical Downlink Shared Channel (PDSCH) transmission or a Physical Downlink Control Channel (PDCCH) transmission that indicates downlink semi-persistent scheduling (SPS) release within subframe(s) n−k intended for the UE and for which an ACK/NACK response shall be provided. Specifically, k∈K, and K is defined in FIG. **2**.

SUMMARY

[0006] One embodiment is directed to a method including utilizing HARQ process grouping and subframe grouping to carry ACK/NACK transmissions. The HARQ process grouping may include dividing HARQ processes into one or more groups. The subframe grouping may include dividing a radio frame into one or more groups. The method may further include carrying ACK/NACK transmissions.

[0007] Another embodiment may include an apparatus which may include at least one processor and at least one memory including computer program code. The at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to utilize HARQ process grouping and subframe grouping to carry ACK/NACK transmissions, wherein the HARQ process grouping divides HARQ processes into one or more groups, and the subframe grouping divides a radio frame into one or more groups, and to carry ACK/NACK transmissions.

[0008] Another embodiment may include a computer program, embodied on a computer readable medium. The computer program may be configured to control a processor to perform a process including utilizing HARQ process grouping and subframe grouping to carry ACK/NACK transmissions, wherein the HARQ process grouping divides HARQ processes into one or more groups, and the subframe grouping divides a radio frame into one or more groups, and carrying ACK/NACK transmissions.

[0009] Another embodiment is directed to an apparatus including means for utilizing HARQ process grouping and subframe grouping to carry ACK/NACK transmissions, wherein the HARQ process grouping divides HARQ processes into one or more groups, and the subframe grouping divides a radio frame into one or more groups, and means for carrying ACK/NACK transmissions.

[0010] Another embodiment may include a method including receiving ACK/NACK transmissions from user equipment, wherein the HARQ process grouping divides HARQ processes into one or more groups, the subframe grouping divides a radio frame into one or more groups, and one of a HARQ process group ID and a subframe group ID is transmitted when carrying ACK/NACK transmissions, and distinguishing between HARQ process grouping and subframe grouping.

[0011] Another embodiment may include an apparatus comprising at least one processor and at least one memory including computer program code. The at least one memory and the computer program code may be configured, with the at least one processor, to cause the apparatus at least to receive ACK/NACK transmissions from user equipment, wherein the HARQ process grouping divides HARQ processes into one or more groups, the subframe grouping divides a radio frame into one or more groups, and one of a HARQ process group ID and a subframe group ID is transmitted when carrying ACK/NACK transmissions, and to distinguish between HARQ process grouping and subframe grouping.

[0012] Another embodiment may include a computer program, embodied on a computer readable medium. The computer program may be configured to control a processor to perform a process including receiving ACK/NACK transmissions from user equipment, wherein the HARQ process grouping divides HARQ processes into one or more groups, the subframe grouping divides a radio frame into one or more groups, and one of a HARQ process group ID and a subframe group ID is transmitted when carrying ACK/NACK transmissions, and distinguishing between HARQ process grouping and subframe grouping.

[0013] Another embodiment may include an apparatus including means for receiving ACK/NACK transmissions from user equipment, wherein the HARQ process grouping divides HARQ processes into one or more groups, the subframe grouping divides a radio frame into one or more groups, and one of a HARQ process group ID and a subframe group ID is transmitted when carrying ACK/NACK transmissions, and means for distinguishing between HARQ process grouping and subframe grouping.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] For proper understanding of the invention, reference should be made to the accompanying drawings, wherein:

[0015] FIG. **1** illustrates a configuration of an LTE-Local Area Network according to one embodiment;

[0016] FIG. **2** illustrates a downlink association set index K: $\{k_0, k_1, \ldots, k_{M-1}\}$ for time division duplex;

[0017] FIG. **3** illustrates corresponding Physical Uplink Control Channel (PUCCH) resources that may be necessary for each of five options according to one embodiment;

[0018] FIG. **4** illustrates a PUCCH format for HARQ process grouping according to one embodiment;

[0019] FIG. **5** illustrates a PUCCH format for subframe grouping according to one embodiment;

[0020] FIG. **6** illustrates a PUCCH format that utilizes HARQ process grouping and subframe grouping (and also with a 1 bit indicator) according to one embodiment;

[0021] FIG. **7** illustrates a PDCCH format for HARQ process grouping according to one embodiment;

[0022] FIG. **8** illustrates a flow diagram of a method according to one embodiment.

[0023] FIG. **9** illustrates a configuration of devices according to one embodiment.

[0024] FIG. **10** illustrates an apparatus according to one embodiment.